

NYSDEC In-House Discussion: The Implications of Approved Continuous $PM_{2.5}$ FEM_{III} Instruments

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NYS Department of Environmental Conservation



	FRM	FEM Class II	FEM Class III	ARM
Defined as	Method defined by Appendix L to Part 50 for PM _{2.5} or Appendix O for PM _{10-2.5}	Samples collected by filtration, with filter conditioning, and gravimetric analysis, but having substantial design differences from FRM	Having one-hour or less concentrations as well as 24-hour	Continuous PM _{2.5} method approved within a State or local air monitoring network
Design or performance based	Design	Performance	Performance	Performance
Filter/Continuous	Filter-based	Filter-based	Continuous	Continuous
Time Resolution	24-hour	24-hour	Hourly	Hourly
Network Applicability	National	National	National	Individual Network
Applicable to	PM _{2.5} , PM _{10-2.5}	PM _{2.5} , PM _{10-2.5}	PM _{2.5} , PM _{10-2.5}	PM _{2.5} only

ARM: Approved Regional Method

PM_{2.5} Class III FEM Testing Requirements

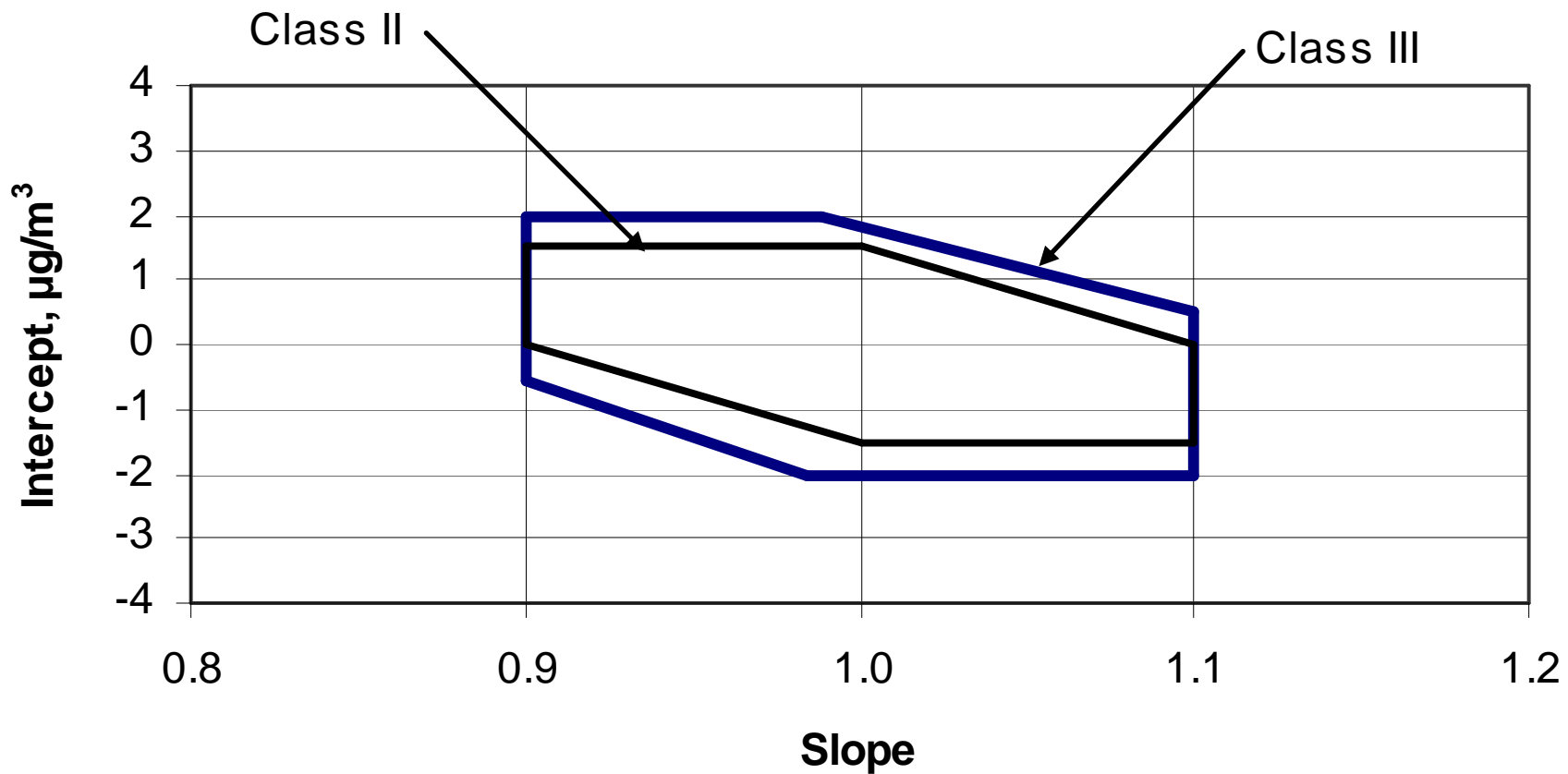
- Vendor driven process – submits application to EPA ORD
 - Three vendor operated FRM samplers and three candidate FEM samplers for each test campaign.
Results are averaged and not reported individually
(More robust – Less realistic)
 - Minimum of 23 valid sets of data per campaign (22 – 25 hours in duration for each sample).
(No requirement to start at midnight – Written for Hvol PM-10)
 - Total of 4 test sites (5 campaigns).
 - Criteria for comparison FRM to FEM: multiplicative bias, additive bias, and correlation.
 - Candidate method must “pass” at each test location
(Winter/Summer location: Data is averaged)

PM_{2.5} Class II and III Test Site Summary

Test Site	A	B	C	D
Location Area	Los Angeles basin or California Central Valley	Western city such as Denver, Salt Lake City, or Albuquerque	Midwestern City	Northeastern or mid-Atlantic city
Site Characteristics	Relatively high PM _{2.5} nitrates, and semi-volatile organic pollutants	Cold weather, higher elevation, winds, and dust	Substantial temperature variation, high nitrates, wintertime conditions	High sulfate and high relative humidity
Class III Field Test Campaigns	Winter and Summer-Avg	Winter	Winter	Summer
Class II Field Test Campaigns	Site A or B, any season		Site C or D any season	

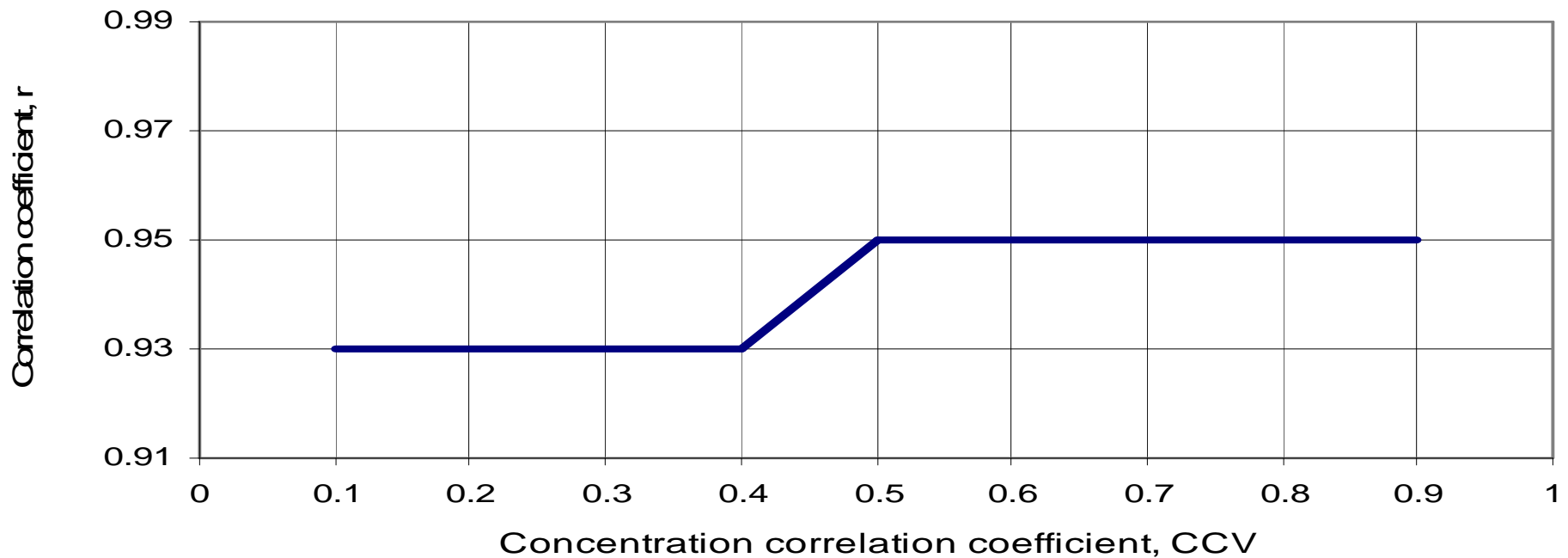
Performance Criteria for Approval of Federal Equivalent Methods ($PM_{2.5}$)

Acceptance Limits for Slope and Intercept for $PM_{2.5}$ Methods



PM_{2.5} and PM_{10-2.5} Class II and III Methods Correlation Criteria

Minimum Limits for Correlation Coefficient



- Correlation is r (not r^2)
- CCV is a measure of the spread of the sample concentrations

Why continuous $PM_{2.5}$ FEM_{III} data may not be appropriate for attainment demonstrations

Dirk Felton
National Air Quality Conference
Portland, OR
April 6-9, 2008



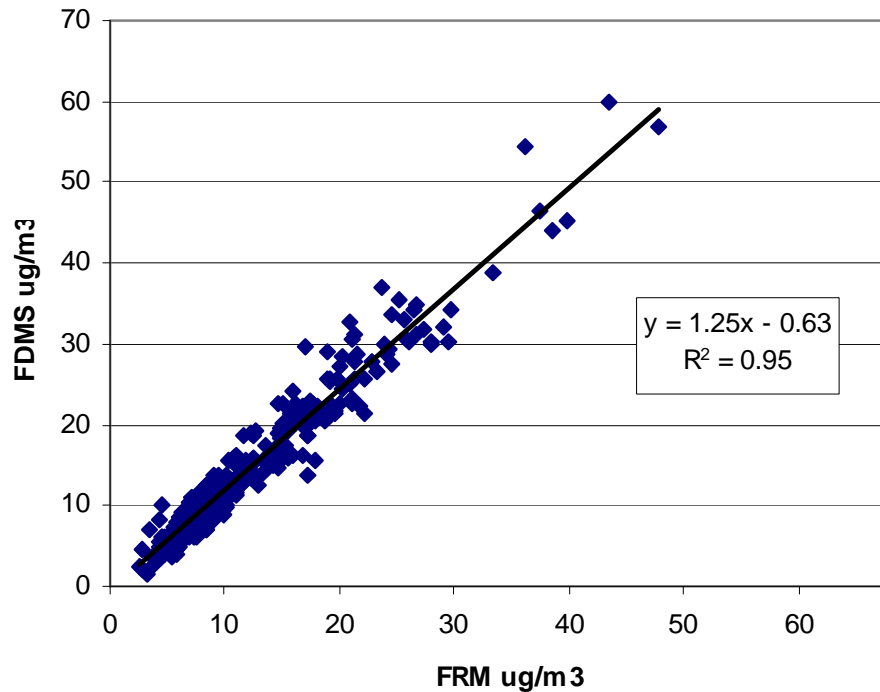
Recent versions of both the MetOne BAM and the FDMS TEOM have been evaluated and compared to a routine daily FRM in New York City.

Both the FDMS and the BAM measure significantly more mass than the FRM. The difference is greater in the summer months.

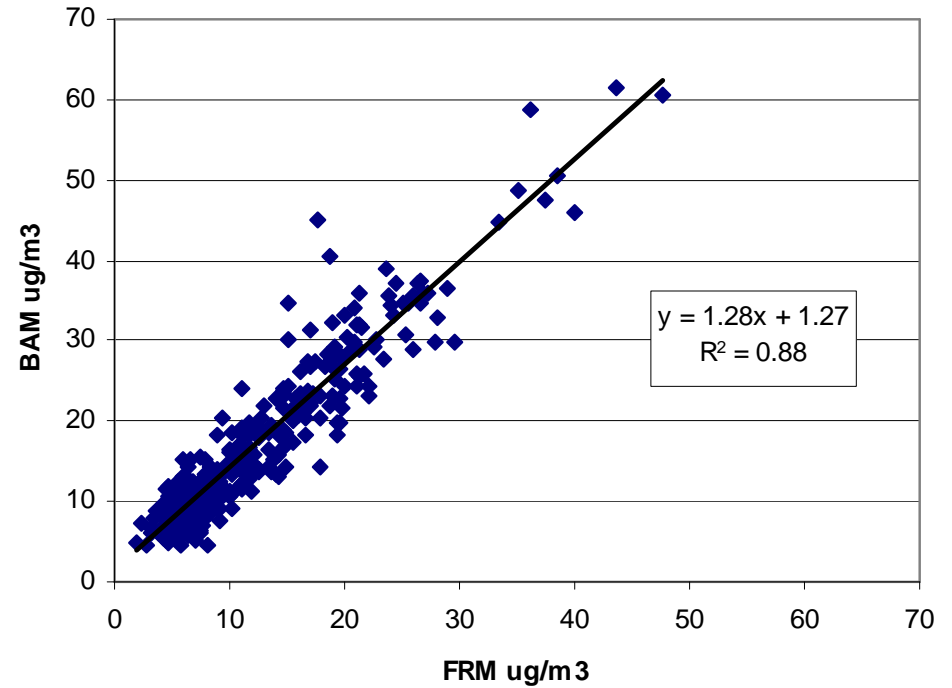
(FDMS TEOM Version B&C)

(BAM with Smart Heater set at 45%)

Queens, NYC Collocated FDMS and FRM
2004 Data (284 Valid Data Pairs)



Queens, NYC Collocated BAM and FRM
2004 Data (321 Valid Data Pairs)



Why doesn't the vendor data match S&L Data?

The candidate FEMs compare more favorably to the FRMs operated by the vendors than to the FRMs operated by the S & L Agencies.

- Primarily because the vendor's triplicate $PM_{2.5}$ FRMs are not operated the way instruments are operated by S&L Agencies.

“there is no requirement that the daily measurements start at any particular time of day, as long as they meet the 22 to 25 hour duration requirement of §53.35”

- The specifications for operating FRMs in the FEM Test Protocols bias the data high when compared to data from FRMs operated in a S&L Agency network.



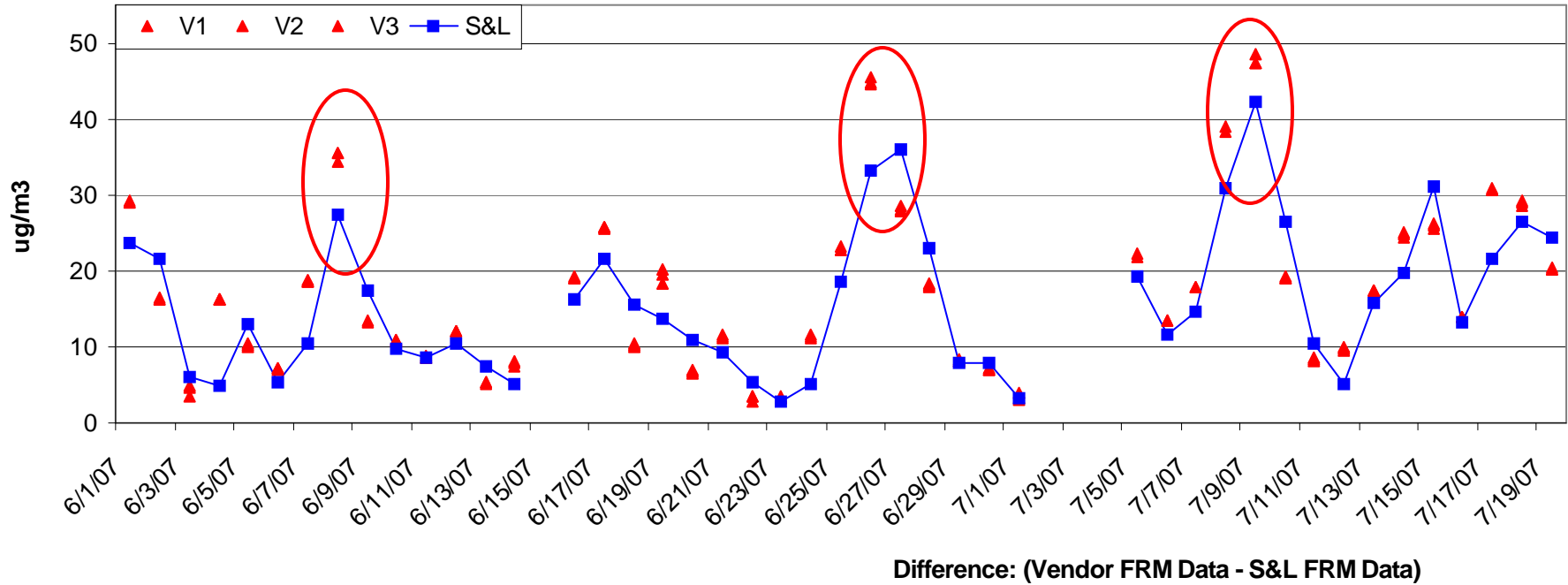
NY Hosted Class III FEM
Equivalency evaluation
for the TEOM 1405 last
summer.

1405 DF TEOM



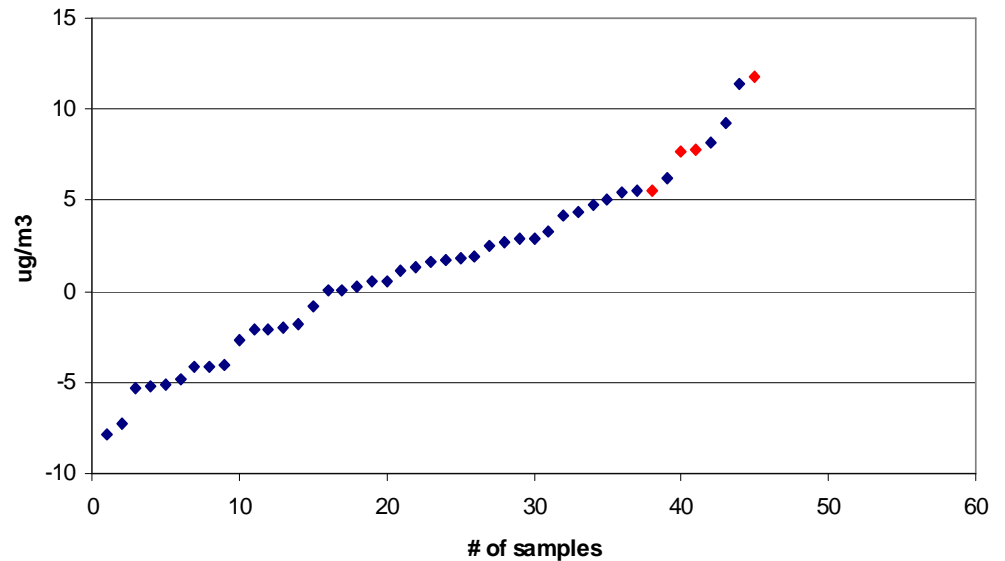


Daily S & L Agency Collection and Daily Triplicate Vendor FRM Data: FEM Test Queens NYC

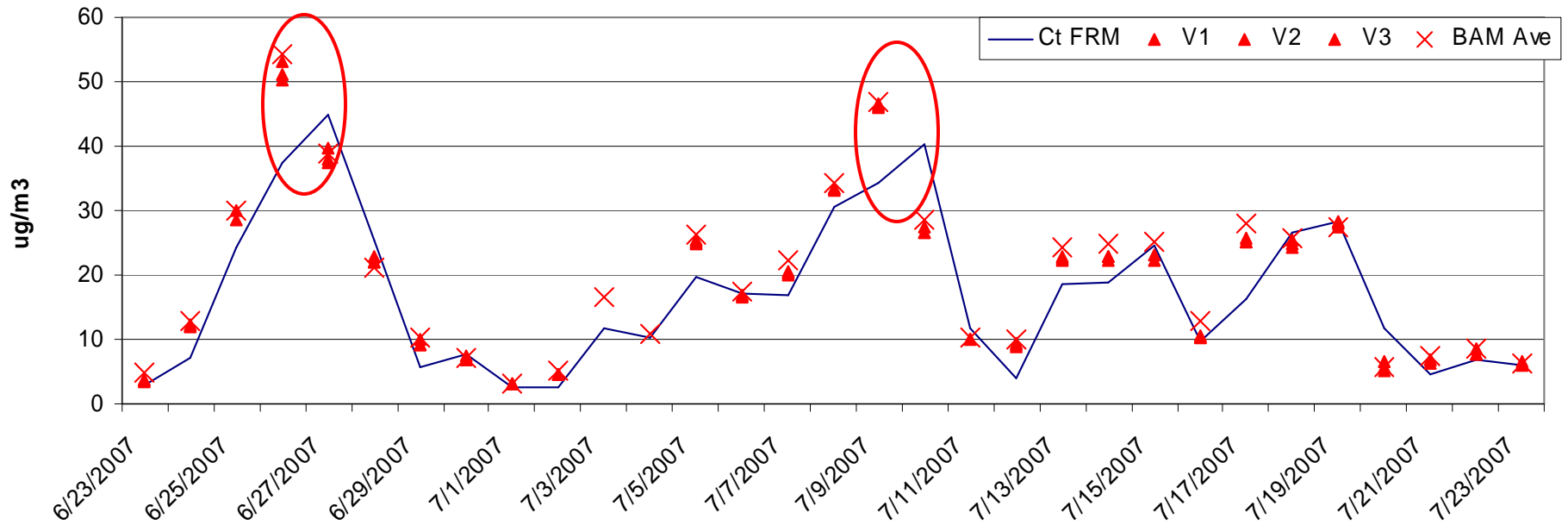


The first thing to notice is that the vendor data is higher than the S&L Agency data on high days. In urban areas, the proportion of volatile mass is often higher on days with high PM_{2.5} concentration.

Vendor: ThermoFisher



Daily S & L Agency and Daily Vendor Triplicate FRM Data: FEM Test NH, CT



In this example, the S & L Agency is different, the vendor is different but the results are the same.

The FEM test protocols produce “FRM” data that is not comparable enough to routine FRM data to provide a basis for determining how a candidate Class III FEM will operate in a real world application.

Vendor: MetOne

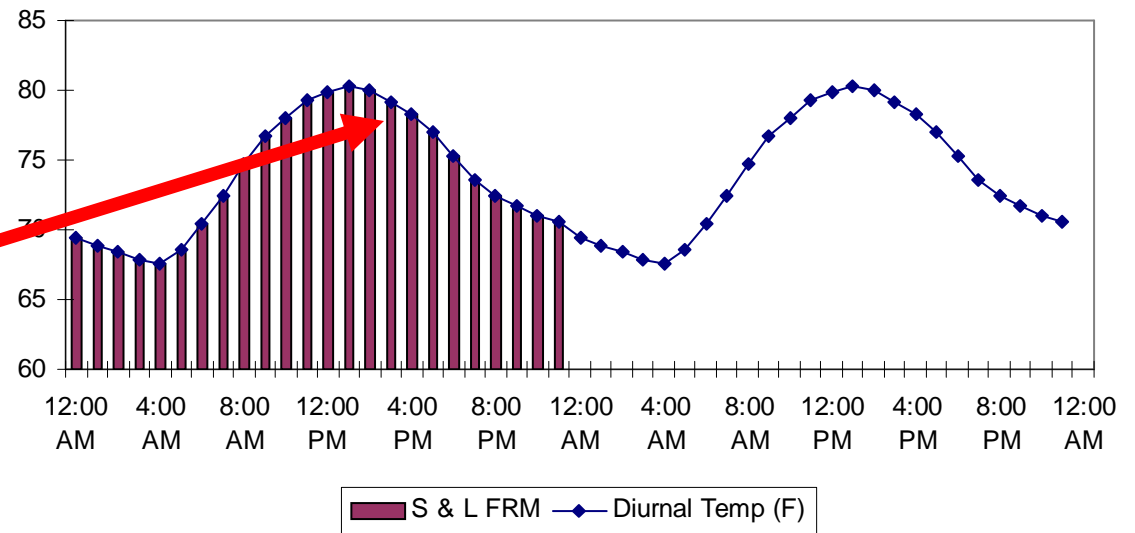


Reason #2:

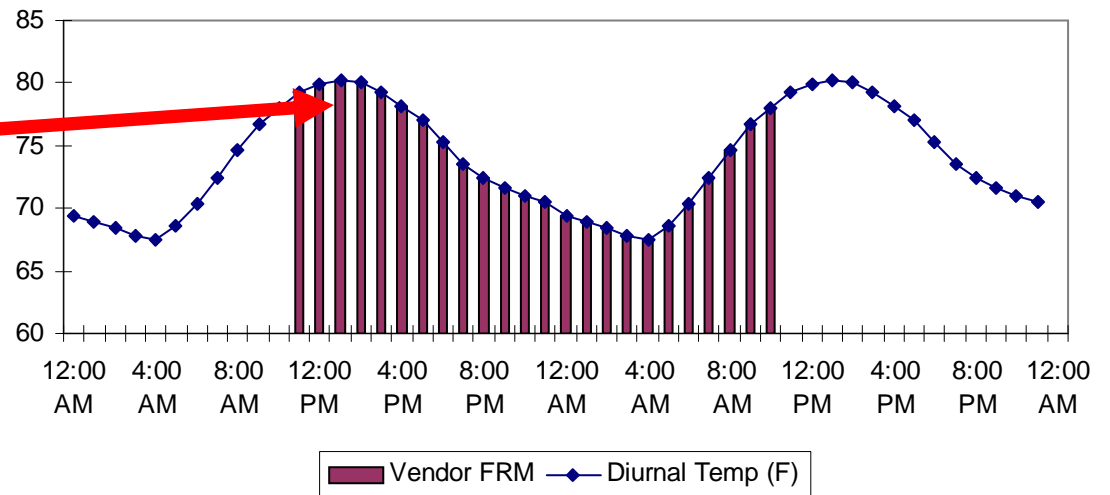
The sample collection interval also effects the FRM's ability to retain volatile mass:

Collecting the sample from midnight to midnight exposes the sample to the highest evaporative losses in the hottest part of the day when the sample is at relatively high loading.

FRM: State & Local Collection Period (Queens NYC)



FRM: Vendor FEM Test Collection Period (Queens NYC)



Collecting the sample from 9:00 to 9:00 or 11:00 to 11:00 am exposes the sample to the highest ambient temperatures before much of the mass has been collected.

(Summer test site actual average diurnal temperatures: Ave 74⁰ F)

What will NY do with Class III FEM Data?

We do not plan to use Method code 88101.

Method code 88500 is more appropriate for these instruments.

Parameter Name	Parameter Code	Purpose	Notes
PM2.5 LOCAL CONDITIONS	88101	Appropriate code for all FRM/FEM/ARMs	Original code for PM2.5 at local conditions
PM2.5 TOTAL ATMOSPHERIC	88500	Valid data from methods measuring total PM2.5 aerosols in the atmosphere, including those that can be volatilized from the FRM	Introduced in 2005
PM2.5 RAW DATA	88501	Valid uncorrected data that does not reasonably match the FRM	Introduced in 2005
ACCEPTABLE PM2.5 AQI & SPECIATION MASS ¹	88502	Valid data that does reasonably match the FRM with or without correction, but not to be used in NAAQS decisions	Introduced in 2006
PM2.5 VOLATILE CHANNEL ¹	88503	Store important related data such as the FDMS reference channel	Introduced in 2006

Figure 1: EPA Technical Note: June 1, 2006

Conclusions

- The Bias is most significant on high concentration days in urban areas in warm months (This is very important for data used for comparisons to the 24-hr std) (Org Carbon & Nitrate)
- The availability of FEMs provides greater flexibility for monitoring Agencies (Can reduce filter based network)
- There is value in producing more accurate, hourly PM_{2.5} data (Health Research, Atmospheric Science Studies)
- The current FEM tests should not be viewed as predictors of results in S&L Agency networks
- NAAQS comparison issues should be discussed with the Regional EPA office before the decision is made to operate and where to operate a Class III FEM



How do we resolve this situation?

MetOne BAMs and FDMS TEOMs work as designed and provide data that includes a higher proportion of the volatile mass

It's the FRM that is flawed. The "Gold Standard" is tarnished and in need of an overhaul. This is not new information.

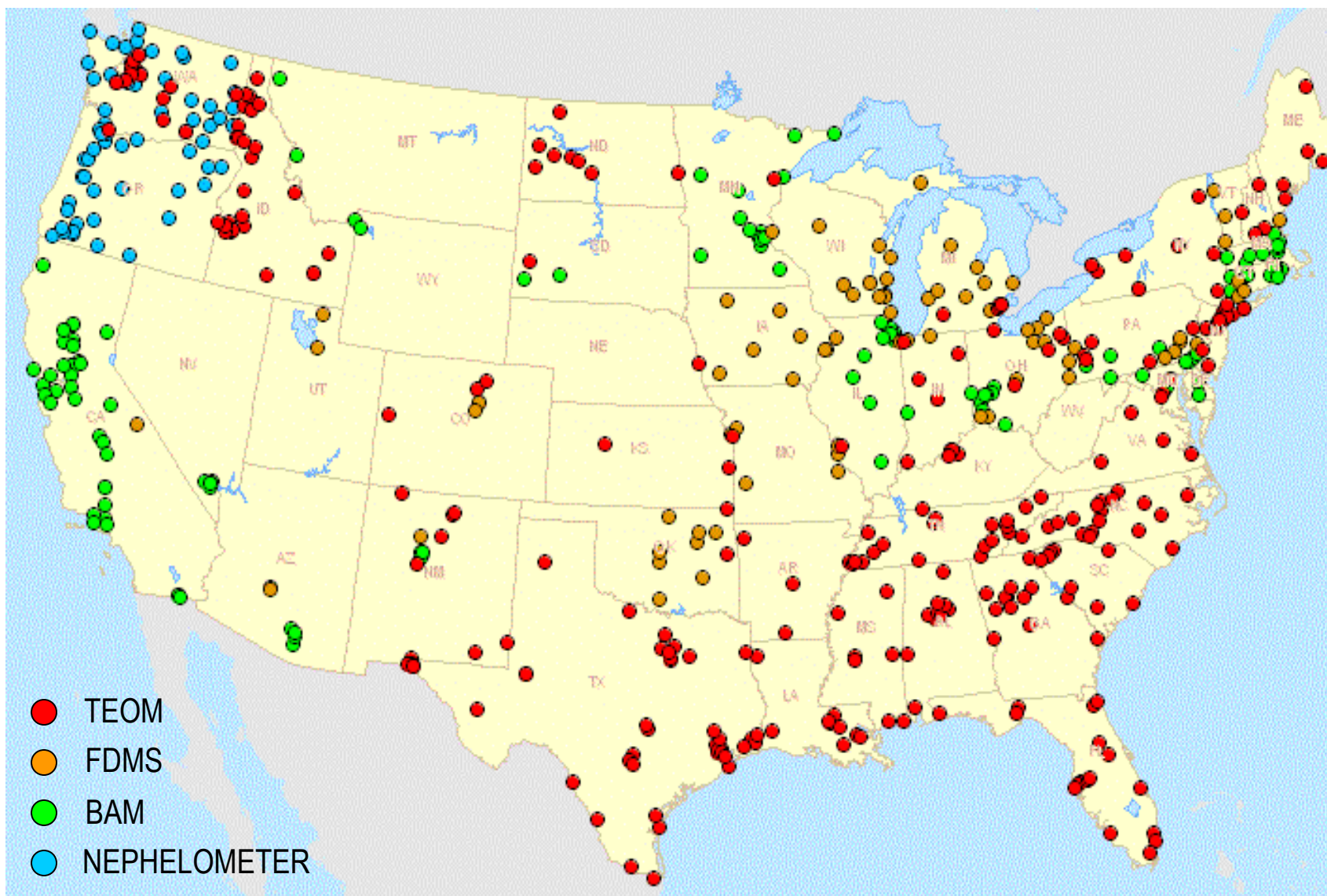
The FRM design should include a chiller to keep the filters cold and a drier to prevent condensation at the end of the sample period.

This design change should be implemented in time for the next review of the PM_{2.5} NAAQS (2010)

The result will be a PM_{2.5} dataset that is more consistent and responsive to the needs of health researchers.
(After all we should try to measure what we are breathing)



PM_{2.5} Continuous Mass Sites by Method





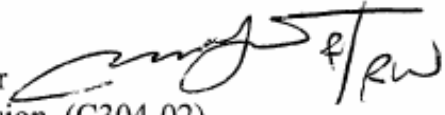
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

JUL 24 2008

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: Implementing Continuous PM_{2.5} Federal Equivalent Methods (FEMs) and Approved Regional Methods (ARMs) in State or Local Air Monitoring Station (SLAMS) Networks

FROM: Richard A. Wayland, Director 
Air Quality Assessment Division (C304-02)

TO: Regional Air Division Directors

I am writing to you to provide information on the use of PM_{2.5} FEMs and ARMs in the SLAMS network. As you may know, EPA's Office of Research and Development recently designated the Met One BAM-1020 monitor as an Automated Equivalent Method with designation number "EQPM-0308-170." This designation was published in Volume 73 of the Federal Register; see page 13224 on March 12, 2008. This is the first automated FEM for PM_{2.5} and others may follow or additionally monitoring agencies may eventually seek and receive approval of ARMs. Unlike non-approved PM_{2.5} continuous methods, monitors that utilize approved FEM or ARM methods produce data that are eligible for comparison to the PM_{2.5} national ambient air quality standards (NAAQS). With this in mind, I am providing a technical note which describes how to address implementation, reporting, and use of the data from FEMs and ARMs in the SLAMS network.

Regulatory Update

The Implementation Guidance:

1. Use of an FEM or ARM PM-2.5 continuous monitor as the primary SLAMS monitor:

If an agency wishes to implement an automated FEM or ARM for PM_{2.5} monitoring for purposes of comparison to the NAAQS 1, it may do so at any SLAMS station at any time during the year. Once designated as the primary monitor, the agency is to submit all data from the FEM or ARM to AQS under parameter code 88101 PM_{2.5} at local conditions, monitor type of "SLAMS," POC 3. (Same parameter Code as FRM, different Method Code, Frequency and POC Code)

2. Use of an FEM or ARM PM-2.5 continuous monitor as a collocated SLAMS monitor:

If an agency wishes to collocate an automated FEM or ARM for PM2.5 monitoring as a SLAMS monitor, but retain the FRM for purposes of comparison to the NAAQS, it may do so at any SLAMS station at any time during the year.

Once designated as SLAMS, but not the primary monitor, **data from the FEM or ARM are eligible for use in calculations for comparison to the NAAQS on days that the primary monitor was either invalid or any day that the primary monitor did not operate.** For this scenario, the agency is to submit all data from the FEM or ARM to AQS under parameter code 88101 PM2.5 at local conditions, monitor type of "SLAMS," POC 3, but keep the FRM as the primary monitor.

Also, this type of collocation (FRM as the primary and FEM/ARM as a collocated monitor) does not meet any collocation requirements for QA purposes.

3. Use of an FEM PM-2.5 continuous monitor as an SPM for purposes of evaluating the method:

Burn In Option: The use of an evaluation period is optional at the discretion of the monitoring agency; however, no more than 90 days are to be used for a burn-in period. During the burn-in period, data are not expected to be reported to AQS.

Evaluation Option: Evaluation periods are normally expected to run for 12 months following the date of installation or upgrading; however, in accordance with 40 CFR Part 58.20, **agencies may use up to 24 months by continuing to designate their FEM as an SPM**. During the period of evaluation, the FEM is to be reported to AQS with parameter code 88101, monitor type "Special Purpose," POC 3.

Agencies should work closely with their EPA Regional Offices on **evaluating the performance of the methods as compared with established performance criteria** such as the Class III equivalency criteria stated in Subpart C of Part 53, section 53.35.

Following completion of an evaluation period, **monitoring agencies may implement the FEM as the primary monitor at any time** during the year.

No EPA direction for what to do if approved FEM does not meet criteria.